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Green microfinance strategy for entrepreneurial transformation: validating a pattern towards sustainability

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This paper illustrates a shifted microfinance modality that adopted greening principles towards sustainability. The empirical context of the research was a green microfinance programme implemented by an NGO microfinance institution at two study sites in Bangladesh. The research conceived and tested a microfinance model underpinned by 'ecological modernization' and 'innovation and entrepreneurship' theories. Field studies were carried out between January 2012 and June 2013 in order to match the 'theoretical realm' with the 'observational realm'. A case study and participatory methods were the primary means of studying the modality and operations of the green microfinance strategy. The study compared the ecological outcomes of green microfinance-assisted enterprises and traditional microcredit-assisted enterprises and measured their greenhouse gas (GHG) emissions. Cool Farm Tool software was used to quantify GHGs. Comparison with a designed experiment shows that micro-enterprises employing green strategies emit less GHGs than the ones with traditional strategies. The research revealed that the microfinance-based greening interventions help to ensure ecological outcomes for micro-enterprises; thus, the combination of the embedded economic and social elements of the classic microfinance model with the new ecological elements supports sustainability.

Keywords: GHG emissions, green microfinance, micro-enterprise, microfinance institution, sustainability

Introduction

The classic microfinance model works to ease economic and social inequalities for the poor by creating micro-enterprises (MEs), generating alternative income sources, forming social capital, and empowering women (Bornstein, 1997; Brigg, 2001; Emami and Branch, 2012). However, the majority of microfinance models currently being practised focus mainly on economic measures and leave environmental considerations unaddressed (Vargas, 2000). Microfinance pioneer Muhammad Yunus (2007) states that the developmental system entails embedded economic and

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social elements. Evidently, the system is yet to integrate the ecological elements that are necessary to support sustainability.

Sustainability implies that a system has properties which will survive or persist over a long period of time, and it encompasses social, economic and ecological elements. As Berkes and colleagues (2003) suggest, sustainability implies maintaining the capacity of ecological systems to support social and economic systems, and it is a process rather than an end product: a dynamic process that requires adaptive capacity for societies to deal with change.

Concerning local contexts, most definitions of sustainability stress striking a balance between environmental concerns and development objectives while simultaneously enhancing local social relationships. In this regard, Bridger and Luloff (1999) state that sustainability at the community level calls for meeting the economic needs of the residents, enhancing and protecting the environment, and promoting better, humane local societies. A comprehensive definition by Zachary is noteworthy here:

> [Sustainability is] the ability of a community to utilize its natural, human, and technological resources to ensure that all members of present and future generations can attain a high degree of health and well-being, economic security, and a say in shaping their future while maintaining the integrity of the ecological systems on which all life and production depends. (Zachary, 1995: 8)

Integration of ecological elements is, therefore, an imperative for a developmental system to be sustainable. Recent literature argues that microfinance systems have the potential to support sustainability if ecological objectives are incorporated within the classic model (Shahidullah et al., 2013; Allet and Hudon, 2013). There are anecdotal examples of green principles being incorporated into microfinance mechanisms, and their applications differ in accordance with varied strategic approaches. Most greening approaches rely primarily on lending organizations (i.e. microfinance institutions), with a core strategy being a shifted microcredit delivery system encompassing environmental compliance as a lending criterion (GreenMicrofinance, 2007; Hall et al., 2008).

Although there are a variety of greening practices, few offer strategic direction and specific area emphasis. First, the MFI-led strategy, which entails the design of financial products to promote environmentally-friendly activities and technologies, organization of campaigns promoting pro-environmental behaviours, and the screening of loan applications along environmental lines, is chiefly based on delivery policies (Allet and Hudon, 2013). Second, the development–environment-focused strategy urges the use of microfinance as a tool to protect biodiversity in integrated conservation and development projects (ICDPs) (Araya and Christen, 2004). Third, the policy-oriented strategy emphasizes policy shifts: urging NGO-MFIs and development partners to facilitate environmental orientation towards community-based micro-enterprises, and promoting greening efforts institutionally (Shahidullah and Haque, 2014).

Against this backdrop, this study empirically examined a development intervention project that incorporated ecological objectives with the classic

micro-entrepreneurship model to develop green micro-enterprises at community level. It attempted to determine whether the incorporation of ecological elements in the classic microfinance strategy helps sustainability. The study conceived a local sustainability pattern incorporating a set of theoretical and assumed elements juxtaposed with a classic microfinance schema – a 'theoretical realm'. These elements were matched and then validated via observations made of a green micro-enterprise component of the development intervention project – an 'observational realm'.

Theoretical realm

Drivers, ideas, and hunches

In the post-colonial period, developing countries witnessed a dispersal of *developmentalism* – systematic and gradual 'un-underdeveloping tasks' (Escobar, 1995). Subsequently, the focus of development discourses began shifting towards alternative agendas, such as human development, rural development, community development, sustainable development, and local sustainability (Ghosh, 2009). A new development strategy centred around microcredit emerged in the 1980s with poverty reduction as the main goal. There are other goals embedded within it, such as the empowerment of rural communities, especially women.

Developmentalism, meanwhile, started to highlight the importance of integrating ecological considerations driven by the principles of renewability, sustainable use of non-renewable resources, and recycling (Daly and Cobb, 1989). With those considerations, the perspective of 'green development' began gaining prominence in developmentalism as 'environmental sustainability' emerged at the forefront of global developmental discourses (e.g. UN Millennium Development Goal 7). This goal of the MDG agenda is reinforced by the finding of the Millennium Ecosystem Assessment (MA) that 60 per cent of ecosystem services are being degraded systematically (MA, 2005). The MA therefore urged businesses to respond to the situation as they depend heavily upon natural capital (MA, 2005). Following the MDGs and the MA, the World Resource Institute called for action at the local community level and revision of the traditional mode of entrepreneurship towards offsetting environmental degradation and the depletion of local natural resource bases (WRI, 2010).

Together with climatic phenomena, the global attitude towards environmental sustainability has redefined the current business environment (Gallo, 2011; Montiel, 2008). Entrepreneurial responses to environmental concerns are increasing. Consequently, a number of environmentally compliant transformative modes of businesses are emerging, such as environmental enterprises, eco-enterprises, green enterprises, conservation enterprises, and sustainability enterprises, where the terms 'green' and 'environment' are used interchangeably (Schaper, 2010).

Despite such environmental responses from business enterprises, much remains unknown about how or why micro-entrepreneurs choose or choose not to incorporate environmental considerations into their business models, particularly in developing countries (Archer and Jones-Christensen, 2011). Lal and Israel (2006) cited that there are micro-enterprises which acquire green inputs for production, such as

organic seeds, composted manure, and organic dyes, in order to contribute towards a healthier environment. Such considerations are given in addition to their economic mission. Conversely, Wenner and colleagues (2004) report that the operations of many micro-enterprises have negative environmental impacts, taking into account GHG emissions. They suggest micro-entrepreneurial operations be required to be environmentally-friendly in order to yield dual benefits: 1) GHG emission reduction, and 2) carbon sequestration. These in turn would contribute to sustainability.

The many propositions for ways that micro-enterprises can become environmentally-friendly include: reforestation; conservation tillage; controlled water usage; natural pesticide applications; use of manure; green tools and technologies, such as solar water pumps and micro-drip irrigation systems; and recycling (Hall et al., 2008; MA, 2005). Amid such ideas and hunches, the concept of 'green microfinance' arose in the literature (Allet and Hudon, 2013; Hall et al., 2008; Rouf, 2012; Shahidullah and Haque, 2014). The authors propounded that micro-entrepreneurial operations should generally be linked with the environment. The essential tenets of the concept are: being green and clean, renewability, and biodegradability. As explained in this issue's call for papers:

> Green microfinance attempts to improve the potential impacts of (micro) businesses on the health and living environment of clients and communities. It offers finance with conditions to exclude obsolete polluting or carbon-intensive production practices, as well as to actively support socially and technologically appropriate innovation. Green microfinance may also offer economic incentives for ecological service provision, whereby the promoted practices are linked to conditional credit provisions. (Practical Action Publishing, 2014)

Theories and the pattern

This study draws on the literature of entrepreneurship and environmental and welfare economics for guidance in conceptualizing the transformation of typical microcredit systems into environmentally-friendly ones. 'Ecological modernization' and 'innovation and entrepreneurship' theories form the conceptual framework for the green microfinance modality. The ecological modernization (EM) theory of Janicke (1985) and Huber (1985) claims that qualitative economic growth is possible with the realization of environmental goals. At the micro-economic level, EM assigns a central role to the invention, development and diffusion of new technologies and techniques, and insists on a shift away from reactive control or clean-up technologies towards the development and application of more anticipatory clean technologies through 'ecological switchover' (Gouldson and Murphy, 1997). In addition, innovation brings about a new production function as a result of one or more of the entrepreneurial activities, such as: introduction of a new good; adoption of new inputs; introduction of new technology; opening of a new market; and/or creating a new economic organization (Schumpeter, 1950).

The conceptual pattern of green microfinance (as shown in Figure 1) incorporates ecological elements into the classic microcredit schema, where economic and social elements are equal and embedded (Emami and Branch, 2012; Yunus, 2007).

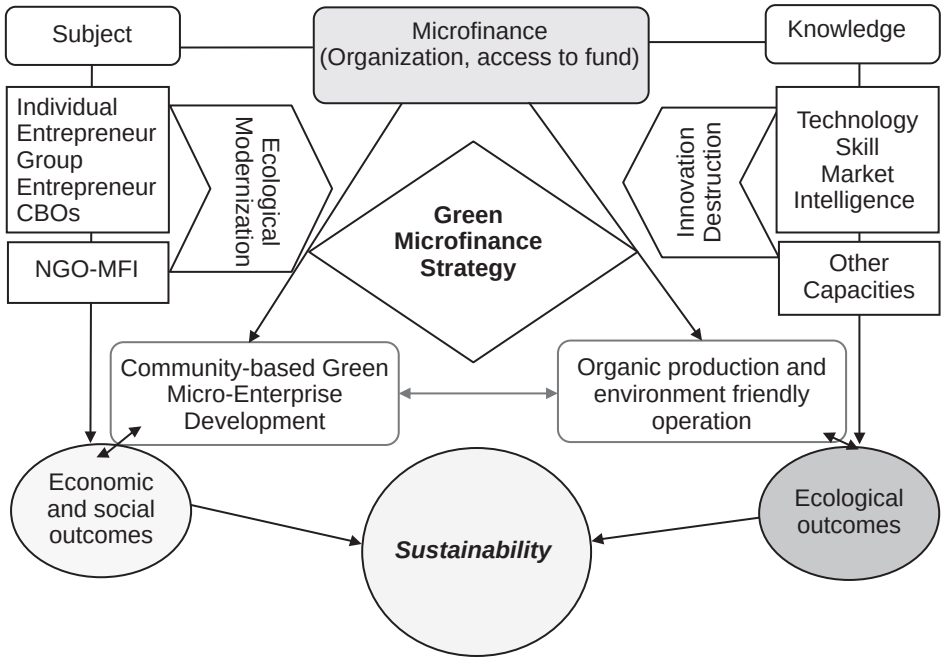

Figure 1 Conceptual pattern of green microfinance

The entrepreneurial subjects work towards achieving ecological goals through shifted operational mechanisms. The infusion of green knowledge in terms of technology, skill, and market intelligence is considered crucial for this form of micro-entrepreneurship as it enables MEs and MFIs to succeed in green innovation.

In sum, putting the intervention case in perspective, the 'theoretical realm' here posits that the combination of economic and knowledge incentives leads innovation in classic micro-entrepreneurial activities, resulting in ecological outcomes while maintaining embedded economic and social ones. It supposes that ecological switchover by green microfinance MEs occurs in terms of input use, technology, production process, energy use, and waste management,—resulting in less GHG emissions relative to those enterprises operating within the classic microcredit schema.

Methodology

The methodology used to conduct this research was guided by 'pattern matching' (Trochim, 1985), which Hyde (2000) finds to be a useful procedure for linking data to propositions. Pattern matching links two patterns or realms where one is theoretical and the other is observational in nature (Trochim, 2006). The theoretical realm is characterized by conceptual drivers, hunches, ideas, theories, and eventually a pattern or 'model' incorporating these elements. The observational realm includes direct observation in the form of field results. Figure 2 illustrates the use of this research design in our study.

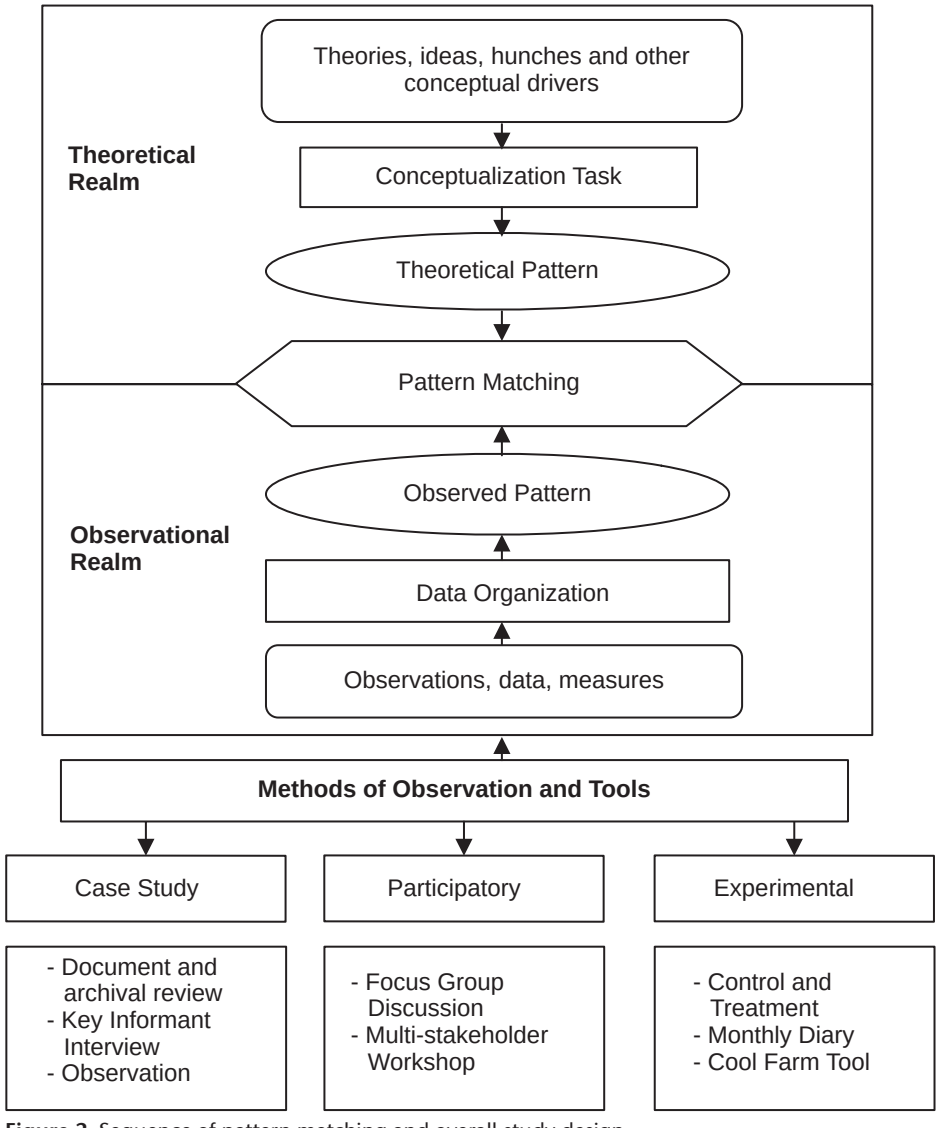

Figure 2 Sequence of pattern matching and overall study design
Source: (Trochim, 2006)

Case study

The main focus of our research was on a place-based case study in Bangladesh, dealing with a green micro-enterprise development programme implemented by the Center for Natural Resource Studies (CNRS), a nationally recognized NGO. Between 2009 and 2013, as part of a pilot scheme, CNRS helped develop 20 green micro-enterprises in nine villages of the Salikha *upazila* (sub-district) of Magura and the Barlekha *upazila* of Moulvibazar districts, where it also runs classic Grameen-model

microcredit programmes. Each village had at least one community-based organization (CBO; 13 in total), which principally functioned as a savings entity for its members.

The data-gathering process included examination of CNRS documents on micro-loan delivery policies, legal and regulatory documents regarding microcredit, greening manuals and operational guidelines, and loan agreements. Six key informant interviews were carried out with: the green microcredit program director, the field manager, two community organizers, one microcredit expert, and one environmental sustainability specialist. During 2012 and 2013, we performed direct field observations in order to record and capture all entrepreneurial activities and the greening practices.

Participatory methods

Applying a number of participatory rural appraisal tools (Chambers, 1997), we organized four focus group discussions (FGDs) with members of the CBOs and local community leaders. The FGDs enabled us to identify ecological and social contributions of the enterprises and to record community members' perspectives on such ventures. In addition, two multi-stakeholder workshops were organized involving local government leaders, government representatives, CBO leaders, civil society members, and individual micro-entrepreneurs from the Salikha and Barlekha *upazilas* to identify priority areas for local sustainability vis-à-vis micro-finance operation.

Designed experiment

In this study we employed a designed experiment which established control and treatment groups in order to measure the effects of green microfinance strategy in terms of GHG emissions. Although in traditional experimental design the pre- and post-treatment outputs are emphasized to compare them with the 'control group' evolution, in our cross-sectional study we regarded the present state of the control group as the pre-treatment condition. The temporal dimension is embedded in our experimental design as the 'treatment group' MEs evolved through the 'greening' interventions.

All 20 MEs participating in CNRS's green microfinance intervention programme were considered the treatment group as they were qualified on submission of their proposals to CNRS. These enterprises were then grouped into five categories based on the nature of their operation (see Table 1). In order to formulate a representative control group, a census of all MEs, but the 20 in the treatment group, operating in the intervention villages was carried out (Flottemesch et al., 2007). A total of 190 such enterprises operating under the classic microfinance system were identified. A comparable group of 20 enterprises out of this total was selected following a stratified random sampling procedure. We adopted a category-wise randomization to obtain a proportionally representative sample from each of the five categories.

We maintained a monthly diary to record the activities, material consumption, and production cycle and practices of both the treatment and control enterprises for one year. The data obtained by the monthly diary were entered into Cool

Table 1 Categories and number of micro-enterprises in 'treatment' and 'control' groups

Category	*No. of enterprises*
Cropping	10
Cane, plants and handicrafts	4
Cattle-rearing	3
Aquaculture	2
Poultry	1

Farm Tool, a software package that calculates GHG emissions by agro-based enterprises (Cool Farm Tool, 2015). The tool has global applicability and follows the Intergovernmental Panel on Climate Change's approach to GHG measurement (Hillier et al., 2011). It accounts for both the sources and sinks of GHGs.

Observational realm: results

'Green micro-enterprise development' was one of four components of a multi-year donor project, namely, 'Building Environmental Governance Capacity in Bangladesh'. The CNRS was responsible for facilitating the establishment of these enterprises through green microfinance strategy. To begin the mission, CNRS initially developed a 'green microfinance operational manual' through consultative multi-stakeholder workshops participated-in by environmental and resource management experts and practitioners, microcredit experts, CBO leaders, resource users and microcredit clients. It then mobilized and reorganized savings groups and CBOs in both the project sites for the purpose of this new initiative.

Building on its network with many of the 13 CBOs in the intervention villages, CNRS subsequently campaigned to raise and enhance environmental awareness among the CBO members. Joint CNRS–CBO meetings ascertained capacity-building measures for adopting and managing green approaches to entrepreneurship. The joint bodies studied the market, socio-economic, and technical feasibilities of such green ventures. As a result of these joint deliberations, nine of the CBOs expressed interest in embarking on green ventures.

Greening strategy

At the initial stage, CNRS played a pivotal role in operationalizing the green MEs. Together with advisory and technical supports by local government institutions at the *upazila* level, adoption of green principles by respective CBOs and micro-entrepreneurs aided in implementing the strategy. The green principles primarily entailed: activities that did not harm the environment; for agricultural production, only manure being used, and no pesticides and herbicides applied; wastes being reused and recycled; and the sustainability of local natural resources being ensured. The overall process of the green microfinance strategy involved four stages with activities focusing on capacity building, entrepreneurial ideas, and effective implementation (see Table 2).

Table 2 Activities involved in different stages of the green microfinance strategy

Stages	*Activities*
Planning	Awareness-raising of CBOs
	Participatory needs assessment – knowledge, capacity building
	Participatory appraisal of market, socio-economic and technical aspects of planned MEs
Development	Training and proposal development
Approval	Local-level screening
	Central-level screening
	Fixing financial modality
	Approval and agreement
Operation	Technical support in the implementation process
	Monitoring

In the planning stage, the CBO members stated that knowledge and capacity-building assistance were their utmost needs in order to embark on green entrepreneurial ventures. The greening strategies therefore adopted several economic and knowledge incentives to enable the borrowers to launch green MEs and maintain their competitiveness relative to the classic ones. The economic incentives included a relatively larger loan size, a flexible repayment schedule, a better interest rate, and small grants from the intervention project. The incentives for knowledge and capacity building primarily comprised training and skill development of the CBO members on environmentally-friendly and organic production, green technologies, and simple bookkeeping for entrepreneurial operations. Further incentives included technical guidance on production methods given by enterprise-specific experts and specialists.

After setting up the green principles and entrepreneurial capacity-building measures, the participating CBO members (borrowers or entrepreneurs) were asked to prepare and submit business plans. Submitted proposals underwent a two-tier environmental screening by both the local and central offices of CNRS; a total of 20 were granted approval. CNRS then determined the financial modality: a monthly loan repayment schedule beginning two or three months after the project's inception. A flat interest rate of 12 per cent on the principal credit amount was applied, while loan size ranged between US$200 and $1,500.

Once a lender–borrower agreement on the financing modality was reached, CNRS made contracts with individual or group borrowers. CNRS also made a separate contract with the appropriate CBOs (where the green entrepreneurs were registered and organized as members) with regard to an 'aid bundle' composed mainly of grants and technical assistance. The grants covered capital equipment and green technologies that amounted to 10–30 per cent of the initial investment costs of the green enterprises. The grants were provided from the donor fund that CNRS received for this component of the intervention project.

Technical assistance was provided mainly in the form of production and implementation guidance. Once the MEs were launched, CNRS facilitated the CBOs

in building networks and obtaining technical guidance from their respective local government departments in areas such as horticulture, fisheries, livestock, agriculture, and cooperatives. It also hired experts to guide and train the green entrepreneurs on enterprise-specific production life-cycle activities and waste management.

Adoption and operation

Adoption and operation scenarios of the 20 micro-entrepreneurs employing a green microfinance strategy were captured via in-depth observation. Monthly diaries recorded their input use, production and energy use, and waste management practices. Among these 20 entrepreneurs, 11 abandoned their earlier venture type and undertook a new one in order to satisfy greening criteria, while nine turned to greening practices without changing the type of venture. Quantified data on fertilizer use, pesticide application, energy use, residue management, and land-use change was collected and can be seen in Table 3. Qualitative and quantitative data gathered on all five categories of ME are summarized as follows.

Inputs. Most micro-entrepreneurs procured organic indigenous seeds and seedling materials. Cropping enterprises used cattle farmyard manure and compost (both fully and non-fully aerated) for land preparation. Aquaculture farms used these materials for phytoplankton maintenance in their ponds. Eleven out of 20 entrepreneurs were found to use organic fertilizers. In addition to their organic fertilization, six enterprises were using nominal amounts of the compound NPK (nitrogen–phosphorous–potassium). A moderate amount of urea fertilizer was used by two cropping ventures for hybrid paddy production, and a cattle-rearing venture for calf fattening.

Six of the cropping enterprises were found to be prone to pest attack. Three of them adopted biological pest control while the other three used chemical pesticides, which they considered more effective than biological control. The farmers were relatively restrained in using pesticides, employing it only in cases of dire necessity. Only one enterprise applied it twice during the winter cropping period. None of the farms used herbicides, choosing instead to remove weeds manually.

Production practices and energy use. Entrepreneurial switchover to green enterprises transformed the production practices and technological choices of the farms. Most of the farms were labour-intensive and had a very low amount of energy use throughout their production cycles. Five farms used mechanized tillage methods, while all others (15) maintained a zero-tillage practice due to the nature of their operation or production choices. Manual harvesting of products also did not demand any energy-consuming technology. Two farms converted barren non-vegetated land into vegetable gardens.

The major reason for direct energy use by the farms was irrigation from both surface and groundwater sources. Average yearly energy use of the cropping category farms was 13.5 litres of diesel per acre. Nursery and vegetable farms irrigated with a submersible water pump, while aquaculture used diesel pumps to dewater fish ponds

Table 3 Annual operations and input of green micro-enterprises

Category (no. of MEs)	*Land (acre)*	*Fertilizer (kg/acre)*	*Pesticides (times used)*	*Energy (litre/acre)*	*Land-use (times changed)*	*Residue/ acre*
Cropping (10)	0.23	26.09	1	17.39	0	52.17
	0.13	0.00	0	0.00	0	46.15
	0.31	38.71	1	16.13	0	80.65
	0.41	34.15	2	14.63	0	82.93
	0.35	17.14	0	17.14	0	120.00
	0.31	19.35	0	19.35	0	122.58
	0.25	0.00	0	16.00	0	48.00
	0.45	17.78	0	13.33	0	53.33
	0.28	0.00	0	14.29	1	42.86
	0.30	13.33	0	6.67	0	33.33
Cane, plants (4)	0.41	0.00	0	0.00	0	68.29
	0.36	5.56	0	0.00	1	94.44
	0.24	0.00	0	0.00	0	66.67
	0.25	0.00	0	0.00	0	60.00
Cattle-rearing (3)	1.00	0.00	0	0.00	0	1,100.00
	1.00	0.00	0	0.00	0	287.20
	1.00	62.00	0	0.00	0	542.00
Aquaculture (2)	0.54	0.00	0	29.63	0	0.00
	0.32	0.00	0	37.50	0	0.00
Poultry (1)	0.02	0.00	0	0.00	0	1,825.00

during the dry season for harvesting. No measureable amount of energy was used by the poultry category enterprise, which was a non-farm duck-rearing venture.

Two of the three cattle-rearing enterprises installed anaerobic bio-digesters that used manure to produce biogas for cooking. Of the four plant and cane materials-producing farms, three were engaged in the production of a plant locally known as *maila* – an aquatic weed that requires only water to grow and is used for making an indigenous bed-mat called a *hugla*. These farms were located on riverbanks and required no energy, fertilizer or any other input except human labour. Another farm engaged in cane cultivation around a homestead and canal edge also employed only labour for its production.

Waste management. All the studied MEs generated waste, but recycling practices among them varied widely. The enterprises engaged in cropping (vegetables, paddies, legumes and other root crops) mostly exported the wastes off-farm and composted these with cow dung into manure. Apart from biogas production, two

cattle-rearing enterprises used their manure for cooking as well as for composting, leaving only 3 per cent of total waste non-recycled. One enterprise made charcoal sticks from cow dung to sell in the local market as cooking fuel. The enterprise that did not install a bio-digester generated around 15 per cent non-recycled waste (which is 1,100 kg a year).

Cane and plant cultivation enterprises generated very little off-farm waste (less than 1 per cent of the harvest). The on-farm wastes of the duck rearing were mixed with household and cattle wastes to become fertilizer. As the ducks were reared in open wetlands during the day, their off-farm wastes went as 'daily spread' into the environment. Data on MEs and their inputs, production practices, and waste output, as shown in Table 3, reveal that the borrowers attempted to avoid and/or minimize the use of chemical fertilizers and pesticides; minimize consumption of energy use; reduce waste production; and avoid land-use change.

Ecological efficiency in GHG measure

The ecological efficiencies of the 20 MEs in the treatment group (green microfinance) and the 20 in the control group (traditional microfinance), in terms of GHG emissions, were measured using the Cool Farm Tool software. Emission records of the treatment group enterprises, as demonstrated in Figure 3a, were: yearly sequestration of CO_2 by nine MEs was more than what they emitted, resulting in a negative net emission; 10 other enterprises had a nominal level of emissions (i.e. less than 500 kg per acre per year); and only one enterprise had GHG emissions above this level, at 620 kg CO_2 equivalent per acre per year.

Figure 3b shows the emission records of the 20 control enterprises: only two out of 20 enterprises had negative net emissions (i.e. 18 enterprises contributed positively to GHG emissions); 11 enterprises emitted more than 500 kg of CO_2 equivalent GHGs per year per acre; and the emission quantity of seven enterprises was within 160–500 kg per year.

Making a category-wise comparison, the majority of the enterprises in cropping and cattle-rearing in the treatment group demonstrated negative yearly net emissions, while all enterprises in the same categories in the control group showed yearly positive net emissions. The poultry control enterprise emitted 2.5 times the GHGs of the poultry treatment enterprise. In the cane and plants category, the annual emission rate of two enterprises in the treatment group was positive, while only one enterprise in the control group had positive emissions. This implies that there was no treatment effect in the plants and cane category.

Discussion

The green microfinance mechanisms triggered the interests of community-based entrepreneurs in adopting environmentally-friendly modes of entrepreneurship. The CNRS–CBO relationships leveraged the introduction of the greening process to the communities. The knowledge base of the entrepreneurial subjects organized under microfinance mechanisms was reinforced with greening ideas

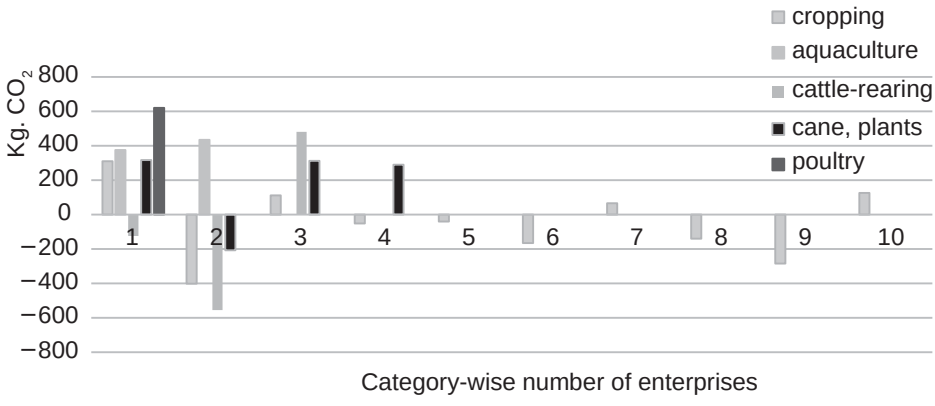

Figure 3a Yearly emission by treatment enterprises

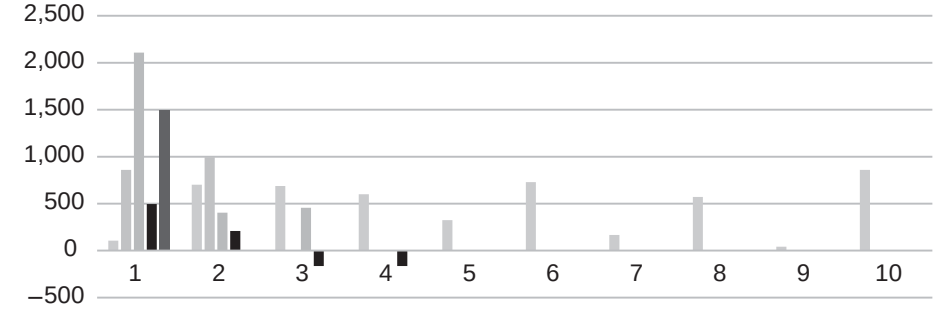

Figure 3b Yearly emission by control enterprises

and skills. Individual entrepreneurs, group entrepreneurs, CBOs and local institutions worked in concert to operationalize the greening approach towards micro-entrepreneurship. There were various drivers of motivation that worked for the NGO-MFI, CBOs, and the MEs respectively in adopting greening principles, which are summarized in Table 4.

The microfinance modality adopted by the NGO-MFI, CBOs and MEs entails strategically shifted characteristics. The shift occurred within several components of the microfinance system, including: the MFI's loan delivery policies, which promoted and linked environmental considerations; a low lending rate (i.e. a flexible 12 per cent interest on capital, whereas the industry average is 15 per cent) (InM, 2011); acceptable and adaptive repayment schedules, such as a monthly rather than weekly repayment collection, with a grace period of three months, which was pioneered within the industry by the MFI (CNRS); and a larger loan size than classical microcredit provisions. It is notable that, within the classical microcredit model, a typical range of initial loan size is $100–200 (Elahi and Danopoulos, 2004). In the green microfinance program, the MFI sanctioned loans up to $1,500. Such expansion in loan amount was attributed to the microfinance industry beginning to consider new sub-sectors that demanded larger investment, including sizeable initial capital (e.g. cattle rearing and aquaculture).

Table 4 Drivers of motivation in adopting green microfinance strategy

NGO-MFI	*CBO*	*ME*
Institutional mandate and mission for environmental sustainability	Reinforcing knowledge and skill through institutional facilitation	Livelihood security
Making microfinance more welfare-oriented for clients	Social learning	Alternative income generation
Innovating developmental approach for ecosystem management and community wellbeing	Enhanced network and consolidated social capital	Profitability
Responding to global developmental initiative and climate change challenges	Community wellbeing, addressing local social–ecological issues	Access to fund for a cheaper rate
Building credibility in niche area, and gaining reputation and synergic learning	Gaining technical support and aid for the organization	Access to institutional supports, e.g. technical aid, guidelines from line agencies, networking

Though receiving the grants from donor-NGO sources was one of the primary motivations for undertaking green ventures, it was not the principal driver for the MEs adopting green practices (See Table 4). At the initial stage, the grants were provided to the CBOs to facilitate launching of the green MEs by their members. Individual MEs adopting green ventures were the targeted recipients of the grants, while all other CBO members had access to the grant materials. One of the prime motivations was that, apart from contributing to the environment, these enterprises generated significant profits. The average profitability ratio of these community-based green enterprises was found to be commercially highly viable (Shahidullah and Haque, 2014).

Encouraged by the success and profitability, these green ventures are likely to be replicated by other farmers, and the practices will likely be continued by the farmers who have already adopted greening principles. It was observed that the CBOs were strongly motivated to remain engaged with protecting and promoting the green entrepreneurial model, as it helped conserve common properties and larger societal interests. CBO members realized that effective promotion of green ventures at the community level will enhance resource bases by reducing pressure on them.

Validating the model

Adoption of greening principles led to innovation by the green enterprises as their operation cycles involved the production of a new commodity or production of an old one in a new way. Innovations were fostered through implementation guidance from the NGO-MFI and technical cooperation from the local government departments (e.g. fisheries, agriculture, and horticulture). Funding from the development partner (concerned with sustainability) helped the NGO-MFI to undertake and implement the green microfinance scheme. This concerted effort resulted in organic production, environmental-friendly micro-entrepreneurial

operation, and environmental amelioration. These findings validate one of the major assumptions of the study that the green microfinance strategy facilitates green innovation.

The study predicted that green microfinance would be invaluable in helping MEs to attain an ecological switchover in terms of inputs, technology, production process, energy use, and waste management. Observed results in the adoption and operation practices of the studied MEs validate this prediction. The experiment found that most enterprises abandoned chemical fertilization and pesticide use in favour of organic fertilizer, adopted biological pest control, and moved to reuse and recycle wastes.

As a result, GHG emissions from most of these green micro-enterprises were found to be significantly lower than those of similar enterprises operating with classic strategies, confirming our prediction. In the treatment group, 45 per cent of enterprises had negative emissions compared to 10 per cent in the control group. The majority of enterprises in the treatment group (95 per cent) emitted less than 500 kg CO_2 per acre per year as opposed to only half (50%) those in the control group.

In order to validate the difference between the yearly emissions of treatment and control groups statistically, we conducted a t-test, the Aspin-Welch Unequal-Variance t-test. The null hypothesis of the test was that the mean net emissions of the control and treatment groups were equal. The experimental data yielded the following values: $t = 3.58$, $df = 30.50$, and $p = 0.001171$. Since the p-value is very small, we rejected the null hypothesis. As a result, the alternative hypothesis that 'the treatment group differed significantly from the control group' stands – validating our assumption that the green microfinance strategy has a significant effect on reducing the GHG emissions of MEs.

Conclusion

This study validates the assertion that the green microfinance strategy helps transform entrepreneurial operational modes by integrating ecological elements with the conventional microcredit system. While such a conventional microfinance system embodies economic and social elements to address development issues at the local level, the integration of ecological elements makes the system tenable to supporting sustainability goals. The conceptual notion pursued in this research that green microfinance strategies would facilitate innovations by the conventional micro-enterprises through ecological switchover is confirmed by the empirical findings of the study. The greening mechanisms formulated and implemented by the NGO-MFI enabled the community-level MEs to shift their behaviour in terms of inputs, technology, production process, energy use and waste management towards sustainability.

The quantitative assessment through experimental design in this study revealed that the economic activities of green MEs emit significantly low levels of GHGs. Statistical test results substantiate the notion that green microfinance strategies are highly effective in reducing the GHG emissions of MEs. A comparative analysis

between treatment and control groups has also demonstrated that the average yearly rate of emissions is much lower among most of the green MEs compared to the classic ones. This finding allows us to conclude that promoting green micro-enterprises would contribute to local and national sustainability goals through reductions of GHGs, if they were scaled up successfully.

The initiative of the NGO-MFI in shifting the classic microfinance modality towards the integration of greening principles is an example of a developmental organization delivering on its institutional responsibility to reinforce sustainability efforts. The research also reveals that the NGO–CBO partnership is crucial to leverage developmental innovation at the local community level. Synergies between the NGO and CBO amplify efforts to address vital developmental and environmental issues, such as the quick adoption of greening principles.

Access to the 'aid bundle' through CBOs was one of the motivations for MEs to adopt green ventures initially. The prime motivations, however, were embedded in economic interests, livelihood security, options for alternative incomes, and a scope for institutional support. The authors envision the replicability of this model, appreciating its potential economic, social and ecological contributions, provided that the green microfinance strategy is scaled-up with the support of relevant line institutions. We recommend that the policy agencies concerned with environmental sustainability and climate change in Bangladesh or in other similar contexts undertake actions to advance and promote the model further as a tool for acting from the bottom-up.

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